Diffraction, shadows, and scattering in electrodynamics: a new view

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Diffraction is the spreading of waves of any kind. The mechanism of diffraction, however, can be quite different for different types of waves.

We show that for electromagnetic waves such as light the diffracted wave of an object is the Ewald–Oseen extinction wave in the far field. The intensity distribution of this wave yields what is commonly called the diffraction pattern. This is the same Ewald–Oseen extinction wave that extinguished the incident wave in the object and thereafter continued to do so immediately behind the object to create a shadow. The object can be an isolated particle or a screen with a hole; in the former case the Ewald–Oseen extinction wave is radiated from the particle, in the latter case it is radiated from the screen. This point of view explains Babinet's principle. If the object is an isolated, non-absorbing particle, nearly half the scattering cross section is in the Ewald–Oseen extinction wave; if the particle has significant absorption, nearly all the scattering cross section is contained there.

Unlike other common waves, such as sound and water waves, electromagnetic waves do not require a material medium in which to propagate. Thus a material object cannot block electromagnetic waves. Hence, light shadows do not form by blocking the light; light does not bend around the edges of the blocking object.

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